Rec'd PTO 1 6 JUN 2006

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/GB05/000023

International filing date: 06 January 2005 (06.01.2005)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0400144.2
Filing date: 06 January 2004 (06.01.2004)

Date of receipt at the International Bureau: 31 January 2005 (31.01.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

The
Patent
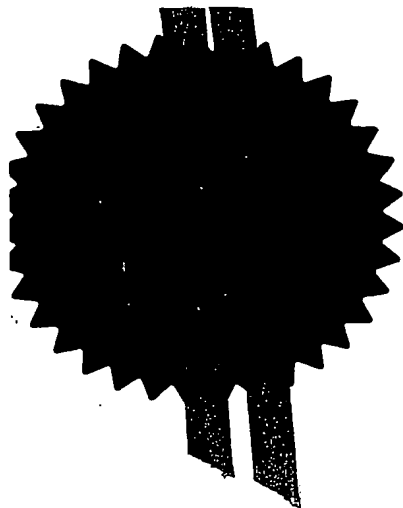**Office**

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated   14 January 2005

An Executive Agency of the Department of Trade and Industry

Patents Form 1/77

THE PATENT OFFICE
CF
- 6 JAN 2004
RECEIVED BY FAX

Patents Act 1977
(Rule 16)

06JAN04 E333321 002001
R01/7700 V 00-0400144.2 NONE

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

Request for grant of a patent

(See the notes on the back of this form. You can also get an
explanatory leaflet from the Patent Office to help you fill in
this form)

1. Your reference	615GB	
2. Patent application number *(The Patent Office will fill in this part)*	0400144.2	- 6 JAN 2004

3. Full name, address and postcode of the or of
each applicant *(underline all surnames)*

Renishaw plc
New Mills
Wotton-under-Edge
Gloucestershire, GL12 8JR

Patents ADP number *(if you know it)*

2691002

If the applicant is a corporate body, give the
country/state of its incorporation

United Kingdom

4. Title of the invention

Inspection System

5. Name of your agent *(if you have one)*

R D Cavill et al

"Address for service" in the United Kingdom
to which all correspondence should be sent
(including the postcode)

Renishaw plc, Patent Department
New Mills
Wotton-under-Edge
Gloucestershire
GL12 8JR

Patents ADP number *(if you know it)*

2691003

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
	—	—	—

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application		Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right
to grant of a patent required in support of
this request? *(Answer 'Yes' if:*
a) *any applicant named in part 3 is not an inventor, or*
b) *there is an inventor who is not named as an
applicant, or*
c) *any named applicant is a corporate body.*
See note (d))

Yes

Patents Form 1/77

1.

INSPECTION SYSTEM

This invention relates to a system for the inspection
of artefacts, in particular but not exclusively to a
5   system employed with a machine tool and to inspection
by means of a measurement device such as a measurement
probe.

Conventionally, a measurement probe is used on a
10   machine tool in a so-called touch trigger mode i.e.
moving the probe so as to touch an artefact and using a
touch trigger signal. The signal is usually routed
through an input of the machine tool's controller (NC)
known as the skip line. This skip signal is a simple
15   on/off signal that can be caused to interrupt the NC
and to record the machine's position (x, y and z
readings) at the instant the skip signal was issued.
Thus data indicative of the probe"s position can be
obtained. Whilst this system is adequate for most
20   purposes it relies on very repeatable probe system
triggering and machine velocity control, and the NC is
often not capable of any significant processing of the
recorded position data.

25   If many data points are required, for example for
determining the correctness of a contour, then the
touch trigger process described above can be time
consuming.

30   In US Patent No. 5,428,548 a probe is used to feel
around the artefact on a machine tool. Inputs from a
scanning probe are fed to a PC which instructs the
machine tool's NC to move to another position. Each
time the probe is moved another set of data from the

2

probe is taken the PC has to wait until the machine
tool has stopped before the probe data is logged. In
this way a data set of probe measurements are produced
which can be associated with assumed machine tool

5   movements. There is no feedback to the PC to confirm
the machine's position. The actual position of the
machine tool is assumed to be correct following
position instructions issued by the PC to the NC.
There is a waiting period to give time for the machine

10 to finish moving.

In a known commercial system by Lemoine Multinational
Technologies, there is provided a path scanning system
which provides part form data which is associated with

15 a machine position. This known system appears to
obtain its machine position data by tapping into the
so-called servo control loop, which allows the
controlling software to obtain tool position data.
This position data together with probe data can be

20 combined but there is no way of confirming that the two
sets of data were truly taken at exactly the same time.

The present invention provides an inspection system
including a method for synchronising data from a

25 measurement device with data from a machine tool,
comprising the steps of:
        issuing a signal at a plurality of instants;
        recording a first set of data relating to the
position of the machine at each of the instants; and

30   recording a second set of data from the
measurement device relating to measurements of the
device at each of the instants.

Preferably the signals at each of the instants is a

3

synchronisation signal which may issue to or from a
machine tool controller. The synchronisation signal
may be used to identify the real time at which each of
the members of the first and second sets of data of the
5   machine tool and measurement device were recorded in
order that the position data and the measurement data
can be combined with the same synchronisation signal.
The combination may take place after the recording.

10   Thus the invention further provides for the step of
combining the first data set with the second data set
such that each element of the two sets are associated
with the same synchronisation signal.

15   Preferably the method further provides the step of
monitoring at regular intervals the measurement device.
This may be done more frequently than the occurrences
of the plurality of synchronisation signals. In this
way only selected data may be recorded to the second
20   set and/or the data may be manipulated prior to its
recordal.

The present invention provides also, an inspection
system including apparatus for synchronising data from
25   a measurement device with data from a machine tool, the
apparatus comprising:
          means for issuing a signal at a plurality of
instants;
          means for recording a first set of data relating
30   to the position of the machine at each of the instants;
and
          means for recording a second set of data from the
measurement device relating to measurements of the
device at each of the instants.

4

The inspection system according to another aspect of
the invention includes also apparatus comprising a
measurement device for use on a machine tool and for
generating measurement data, a machine tool control
5   device operable to move the machine tool and to
generate data relating to the position of the machine
tool, a means for producing a plurality of
synchronisation signals, software for collecting data
from the measurement device and machine tool control
10   device and for associating the data from the
measurement device with the data from the machine tool.

Preferably synchronisation signals are issued at a time
related to the time that position data or measurement
15   data is generated. The synchronisation signal may be
used to label both measurement and position data
generated at the time the synchronisation signal was
issued.

20   Alternatively the synchronisation signal may be issued
from a source other than the machine tool control.

The invention will now be described with reference to
the drawings, wherein the Figure shows one embodiment
25   of a measurement system according to the invention.

The Figure shows a machine tool 10 having a control
device NC 20. The NC is used to control all functions
of the machine tool. Shown in the drawing are servo
30   control and position feedback lines 30. These lines
are used to control x,y and z movements of the machine.
A spindle S (in this instance fixed in position) can
accept a measurement probe P. The probe is used to
check the dimensions of workpiece W mounted to the

5

machine tool as the workpiece is moved in x, y, or z directions. The probe P is of a type which can produce data representing the deflection of its stylus and can produce many results per second. The stylus deflection

5   data is transmitted to a receiver, Rx 40. The NC 20 has position feedback lines which are also capable of receiving data relating to the x,y and z positions of the machine many times per second.

10   A PC 50 is provided which has an interface circuit 60 e.g. a PCI, PCMCIA, Ethernet or USB type. The interface is capable of receiving and buffering data from the Rx along line 62, relating to probe stylus deflections. In this embodiment line 62 also provides for sending probe

15   instructions. The PC accepts data, via line 32, relating to the positional machine tool movements. In the present embodiment the machine tool movements are directed straight to the PC, but they could be routed via interface 60.

20

The interface can be used to buffer data received from the probe (and from the NC if appropriate). The buffer can store the data to send to the PC later. The interface can also use immediately the data coming from

25   the probe to monitor conditions which require action e.g. over-deflection of the probe stylus. In such an instance of over-deflection the interface could issue a signal immediately to stop or reverse the machine's movements. Machine position data gathered immediately

30   before the stop can be used to facilitate such action.

Where the interface is in control of real time over-deflection etc monitoring, then it is possible that the PC can instruct the interface to alter conditions at

6

which over-deflection etc is deemed to have occurred so
that undesirable affects such as false triggering due
to vibration or rapid movement of the probe are taken
into account.

5

These two sets of data can be used by the PC to produce
an accurate profile of the workpiece W. However,
useful computation can be carried out only if the two
sets of data can be combined. In order for this to
happen the relative time at which sets of data were

10   obtained must be known. In operation the NC collects
data relating to the machine tool movement and
tabulates that data in order according to a signal from
an internal clock 22.

15

The internal clock 22 produces the synchronisation
signal 24 and the interface accepts this signal. The
interface too collects data relating to probe stylus
deflection and the PC tabulates that data in order

20   according to the synchronisation signal from the
internal clock 22. In practice the PC can combine
elements of the NC data with elements of the probe data
because both are in the same order and will be in the
same or related field of their respective tables.

25

The PC can thus carry out computation using the data
from the same or related fields in each of the
tabulated data from the NC and the probe.

30   Speed of transfer of data to the PC from the NC and
interface is not significant to the measurement speed
of this system. The speed of transfer of data to the
PC from the NC and interface will be dependent on the
data transfer rate and the size of the memory buffers

7

in the NC and the interface.

Typically the system will operate in the following
manner:

5   the NC will run a program e.g. a program for
cutting a workpiece W;
           the NC will run an inspection routine which
includes the selection of the measurement probe P and
the movement of the workpiece W past the probe along a
10 nominal path defined by the inspection routine; and
           during the routine both the position of the
machine tool and the deflection of the stylus of the
probe are recorded in the manner described above.

15 The PC can compute such things as workpiece size or
form, workpiece surface finish and the assessment of
scrap workpieces. Using such data it can also compute
revised cutting tool paths and new feed and speed
rates.
20
     If required the interface 60 can manipulate the data
from the probe P so that, for example it is retarded or
advanced to match the position data 32 from the machine
tool. In this way repeatable delays from the NC or
25 measurement device can be accommodated. It is also
possible to collect more data from the measurement
device or NC than the other. So e.g. measurement
device data 62 can be collected at 10 times the rate of
the NC position data so that filtering of the
30 measurement device data 32 can occur in the PC,
resulting in better accuracy of measurement.

     To avoid breakage of the probe, one or more event
signals may be incorporated into the interface circuit.

8

Should conditions occur for example deflection of the stylus greater than a threshold then the event signals are sent to the NC along line(s) 26. Such a signal will stop the machine via a conventional skip signal so that
5   the unexpected problem can be overcome.

The measurement device and the interface may have multiple operating modes and these modes may be selected via signals sent to the interface from the PC
10   or from the NC e.g. the enable signal 28 which switches the measurement probe on or off. Signals from the NC may be activated by commands within the NC program.

Many variants will be apparent to the skilled
15   addressee. The separate NC and PC illustrated may be integral. The measurement device illustrated is a measurement probe but other measurement devices can be used e.g. cameras or thermometers. The measurement device need not have wireless communication. A hard-
20   wired arrangement is possible. The probe used is capable of generating a stream of deflection data. The probe could also be used in a touch trigger mode i.e. a predetermined stylus deflection causes just one trigger signal. Such a mode of operation may be useful e.g.
25   when initially setting up a workpiece, when the size of the part is not known exactly. A skip signal (like the event signal described) can be used as a touch trigger signal. The x,y,z position data 32 shown might be replaced or supplemented by non Cartesian data and
30   could be fed into the interface rather than into the PC as illustrated.

Alternatively, in touch trigger mode the data collected from the probe and from the NC can be manipulated to

9

give an apparent touch trigger operation, e.g. by
employing an algorithm which extrapolates data back to
a notional zero point, allowing improved repeatability.

5   The synchronisation signal 24 is illustrated as
originating at the NC. However the signal could come
from another source, e.g. from the interface. Thus it
is possible that the NC would await the synchronisation
signal and produce position data related to the time at
10   which the signal occurs. The interface would do the
same or may issue a synchronisation signal when it
records measurement device data, e.g. at every tenth
recording of data.

1/1

Fig 1

PCT/GB2005/000023